ADVANCED SHIPBOARD CRANE MOTION CONTROL SYSTEM ATD

OPNAV Sponsor: N4; N42, Mr. Kaskin; N422, CAPT (sel) Parke
Technical Manager: ONR 362, Dr. Abraham
Program Manager: PEO SHIPS; PMS 325A, Mr. Fink
Program Execution Manager: NSWCCD 282, Mr. Rausch

Frank Leban, NSWCCD 2820 (301) 227-
lebanfa@nswccd.navy.mil

Problem - Pendulation

Load pendulation is caused by:

- **crane operator**
- **ship motion**
- **system dynamics**

Pendulation slows all crane operations in any sea state and prevents any safe crane operations from high sea state 2 through sea state 3

This ATD solves these problems

ATD OBJECTIVES:

- **Demonstrate shipboard crane pendulation motion control.**
- **Enable crane ship throughput of a minimum of 300 containers per day in sea state three.**

Requirement - Joint Logistics Over The Shore

Cargo Ships

Ship Transfer Cranes/Ramp

Lighterage (INLS)

Shore Systems

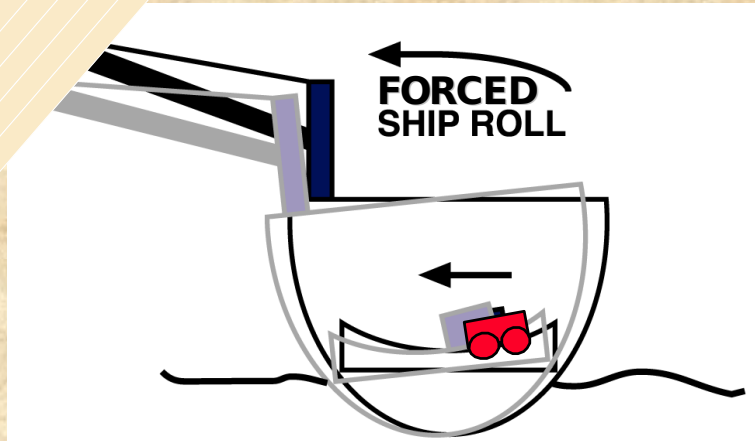
Beach Clearance

TECHNICAL APPROACH

INDUCED MOTIONS → Operator Ship System Dynamics → **NON-LINEAR DYNAMIC CONTROL ALGORITHMS** → Crane control system → **CONTROLLED PENDULATION**

SIMULATION
Computer Simulator/Trainer

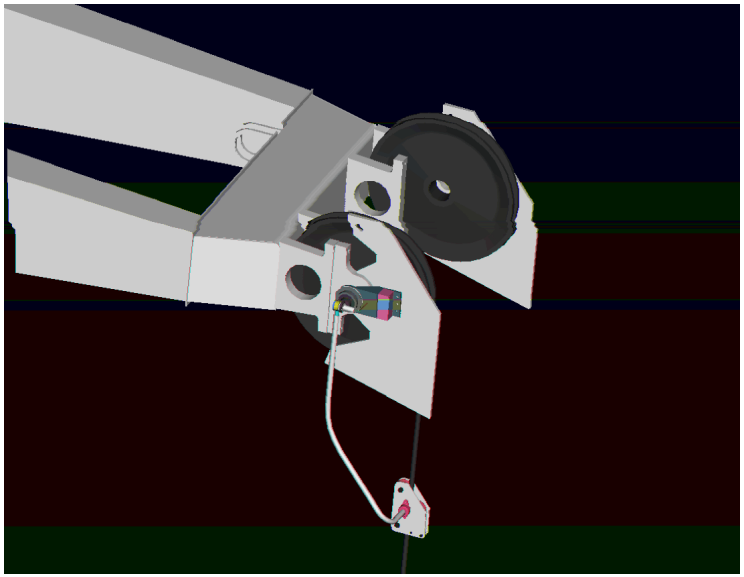
T-ACS ship roll STIMULATION
Demonstration and Training



PCS Hardware Components

PCS

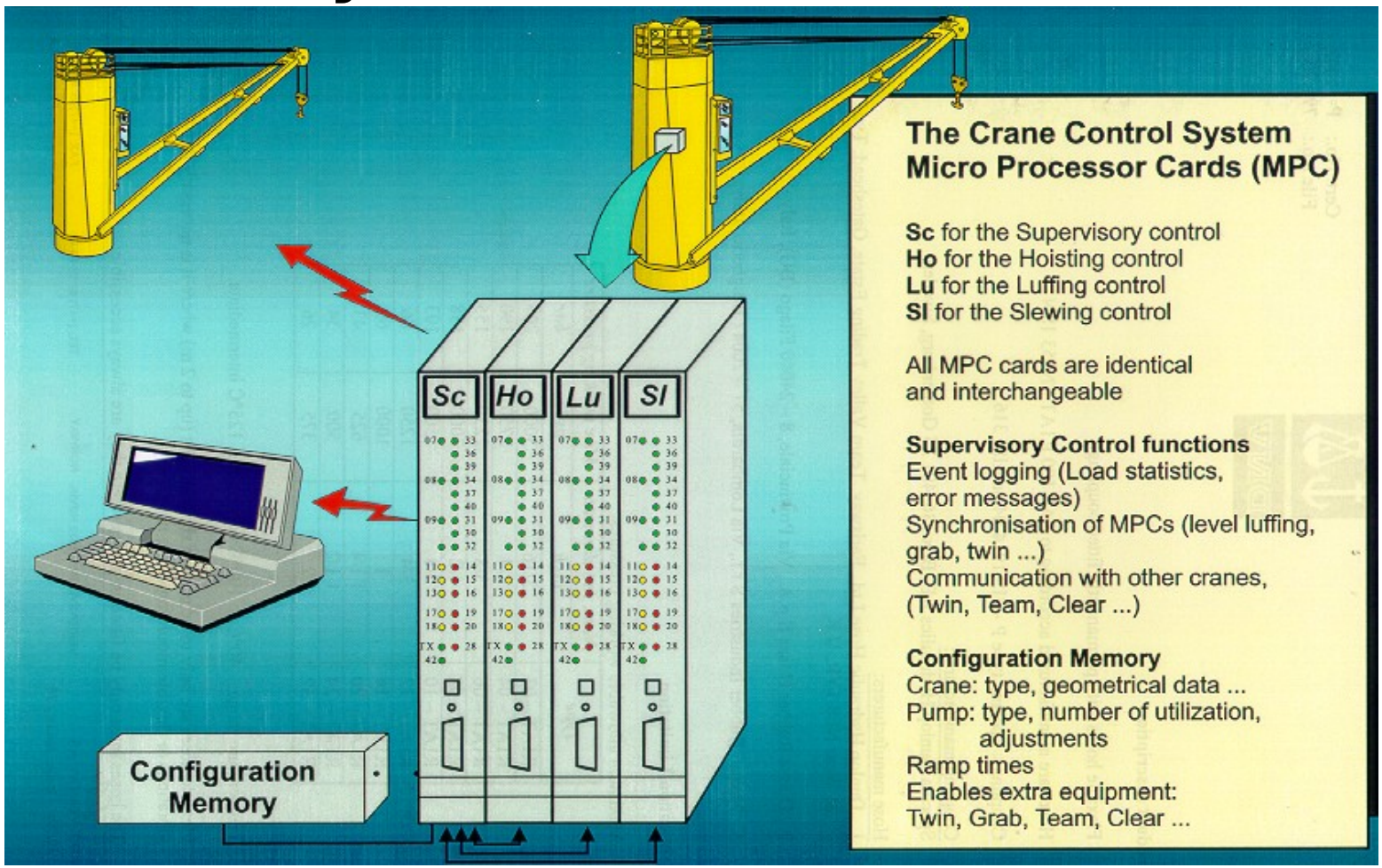
Ship motion sensor



Swing Sensor

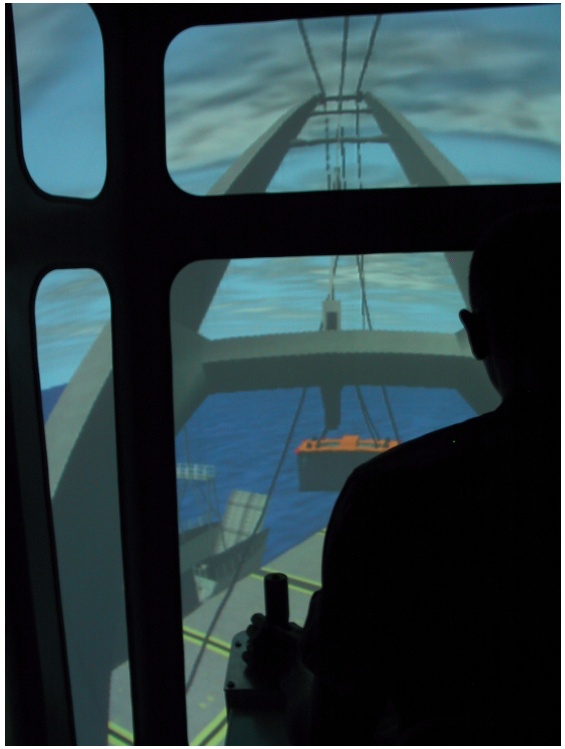
ATD - Mission ”Flickertail State”

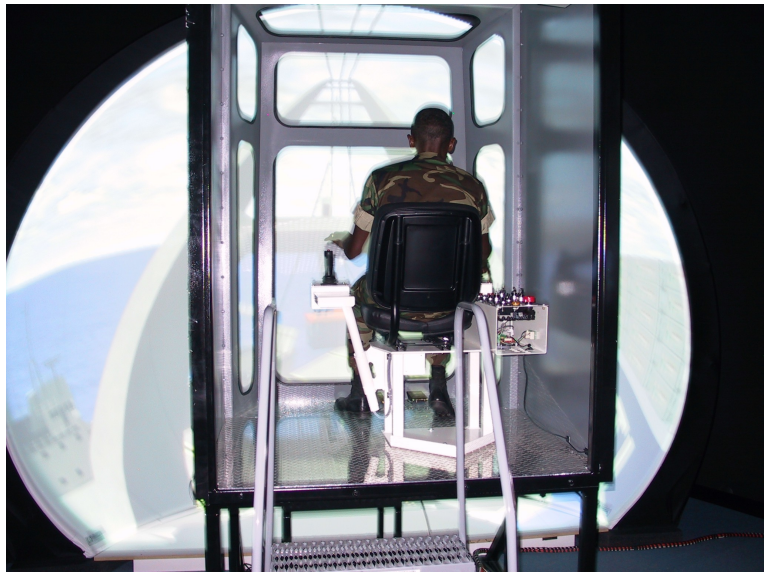
Control system CC2000


Sc
Ho
Lu
Sl
Configuration Memory
The Crane Control System
Micro Processor Cards (MPC)
Sc for the Supervisory control
Ho for the Hoisting control
Lu for the Luffing control
Sl for the Slewing control
All MPC cards are identical and interchangeable
Supervisory Control functions
Event logging (Load statistics, error messages)
Synchronisation of MPCs (level luffing, grab, twin ...)
Communication with other cranes, (Twin, Team, Clear ...)
Configuration Memory
Crane: type, geometrical data ...
Pump: type, number of utilization, adjustments
Ramp times
Enables extra equipment:
Twin, Grab, Team, Clear ...

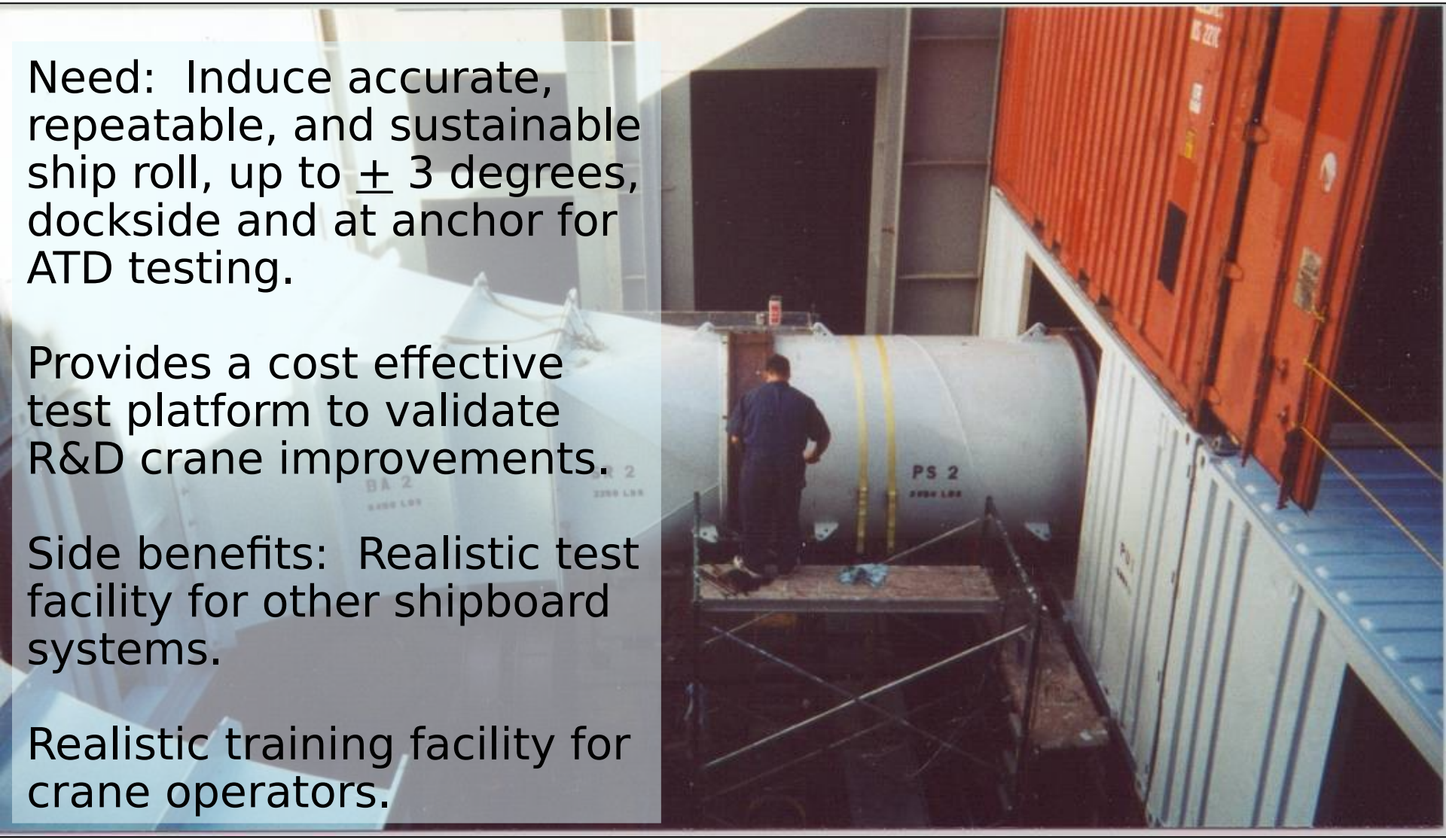
Advanced Crane Simulator

- **NAVCHAPGRU training facility**
- **Engineering testbed for swing-free controller and other systems**
- **Capability to add existing and notional cran**





SHIP ROLL STIMULATOR SYSTEM (SRSS)



Need: Induce accurate, repeatable, and sustainable ship roll, up to ± 3 degrees, dockside and at anchor for ATD testing.

Provides a cost effective test platform to validate R&D crane improvements.

Side benefits: Realistic test facility for other shipboard systems.

Realistic training facility for crane operators.

ATD Demonstration

- **Installation, verification, training and testing (7 weeks)**
- **NAVCHAPGRU crane operators and hatch teams**
- **PCS shakedown**
- **Cargo throughput simulation at varying degrees of roll**
- **Comparison with other R&D efforts (IRBTS, PMC)**

Crane ATD Video Clip

Approx. 8 min.
Edited by Jeff “Spielberg” Green

Advanced Shipboard Crane Motion Control System ATD Status

ONR ATD Completed – > Transition to program management by PEO SHIPS/PMS325A Marty Fink with resource sponsor OPNAV N42

ABS Approval Obtained for Flickertail State Installation

<u>Strategic Sealift R&D Program</u>

- **Final Design & Acquisition Specification**
- **Twinned and Quad Crane Lift Capability**
- **Adaptation of System for Additional Crane Models**

<u>Potential Installation on:</u>

- **Auxiliary Crane Ships 10 ships (54 cranes)**
- **Maritime Prepo Ships 16 ships (73 cranes)**

- **Fast Sealift Ships 8 ships (32 cranes)**

Future PCS Development Possibilities

- **Lighter Deck Tracking**
- **IRBTS Integration (Block Minder)**
- **COD Enhancements - Deck/Height View - Logistics C2**
- **New & Improved Spreader-Bar Messenger Frame w/Deck Positioning Aids**